METER ANTENNA

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FIELD OF THE INVENTION

This invention relates to antennas for use with utility meters.

BACKGROUND OF THE INVENTION

Antenna performance parameters such as efficiency, radiation/reception pattern, and resonant frequency are affected when the antenna is placed in the vicinity of metallic infrastructures. The incumbent or resident metallic infrastructures in conventional electromechanical utility meters (such as GE Watthour Meter I-70-S and ABB AB-1) greatly affect the performance parameters of conventional half-wave dipole or quarter-wave whip antennas when such antennas are incorporated within the confines of a conventional meter. The interactions between the metallic infrastructure in a conventional meter and such conventional antennas are highly sensitive in the sense that the difference in the metallic infrastructures themselves between different meter models is sufficient to cause inconsistent antenna performance. The goal of the invention is to increase the

stability and efficiency of antenna performance over many meter types.

SUMMARY OF THE INVENTION

There is provided an antenna arrangement for a conventional utility meter having a cover and metallic infrastructure plus RF communications capability, comprising a slot antenna formed to fit under the cover and cooperating with said RF communications capability.

There is also provided a method of managing the varying effects of differing incumbent metallic infrastructures on the performance of a radiating/receiving element of an antenna, comprising the steps of inserting a metallic structure closer to the radiating/receiving element than the incumbent metallic infrastructure.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention can be obtained when the following detailed description of the preferred embodiment is considered in conjunction with the following drawings, in which:

FIG. 1 shows an exploded view of a RF retrofit module with the slot antenna of the present invention.

FIG. 2 shows the slot antenna of the present invention, formed to the contour of the RF retrofit module.

FIG. 3 shows the actual dimensions of the slot antenna of the preferred embodiment.

FIG. 4 shows a view complementary to that of FIG 1.

FIG. 5 shows a front perspective, partially broken away view of a meter with the RF retrofit module that includes the antenna invention installed.

FIG. 6 shows a view complementary to that of FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIGS. 1 and 2, a conventional meter **100** houses electro-mechanical (incumbent or resident) metallic infrastructures (consisting of gears, brackets, prongs, tumblers, disks, rivets and the like, identified generally as **140**) enclosed by a transparent (typically glass or plastic) cover **90**. Herein, the term "metallic infrastructure" is meant to describe the (resident or incumbent) infrastructure **140** whereas the term "metallic structure" is meant to describe the contribution of the present invention.

As seen in FIGS. 1 and 2, the present invention teaches the use of a slot antenna **10** and **20** with a RF retrofit module **40** that is placed within meter **100** under the cover **90**. RF retrofit module **40** has transceiver assembly **70** and is shaped to be attached to

the resident metallic infrastructure **140** of meter **100.** Details of quarter-wave slot **125** in antennas **10** and **20** are explained below. The fully assembled version of the exploded view of FIGS. 1-2, is shown in FIGS. 5-6.

Those skilled in the art realize that an efficient antenna that is insensitive to meter incumbent metallic infrastructures placed in its vicinity, faces conflicting requirements. In the present invention, the quarter-wave radiating slot **125** is inherently adjacent to the metallic structure of the brass sheet **115** it is cut out of. Thus the metallic infrastructure **140** of the conventional meter **100** is relatively "far" away from the slot **125**, resulting in an antenna that is less sensitive to de-tuning when compared to the aforementioned conventional antenna types.

Cover **90** is typically frusto-conical (as the result of conventional manufacturing processes). RF retrofit module **40** is pre-formed and shaped accordingly as a smaller frusto-cone to fit under cover **90**. The frusto-conical shape of the brass sheet **115** is required to form snugly over the upper surface of RF retrofit module **40** as seen in FIGS. 1,4, 5-6.

Mounting holes **110** and **120** in antennas 10 and **20** are elongated to allow for thermal expansion and contraction over the expected operating temperature range of the antenna **10** and **20**. Antenna **10** is attached to the RF retrofit module **40** with four plastic rivets **30** inserted through the mounting holes **110** and **120** in FIG. 3 and through the mounting holes **80** in the RF retrofit module **40**. The plastic rivets **30** are heat-staked to complete the fastening.

Antenna **10** is pre-formed to the contour of the RF retrofit module **40** as shown in FIG. 2. In the same fashion the complementary, pre-formed antenna **20** is attached to the

RF retrofit module **40**. Antenna **10** is coupled to the transceiver assembly **70** via coaxial cable **50**. Coaxial cable **50** is soldered to the transceiver assembly **70** at a transceiver coupling point. The other end of coaxial cable **50** is soldered to antenna **10** as per the detail **A** in FIG. 3 at points **130**. In the same fashion antenna **20** is coupled to the transceiver assembly **70** via coaxial cable **60**. The fully assembled RF retrofit module **40** is fastened to meter **100** (by conventional means like screws or snap/friction fit) and enclosed by the cover **90**.

The radiation/reception pattern of antenna **10** is nevertheless perturbed to some degree when incorporated into the meter **100**. Accordingly, in the preferred embodiment, two slot antennas **10** and **20** are used and are placed offset from the center of the top surface of the retrofit module **40**. The resultant dominant null in the radiation/reception pattern for each of antennas **10** and **20** occurs at different azimuths such that one antenna mitigates the null of the other. The selection of antenna **10** and **20** is conventionally performed by the transceiver assembly **70** where the selection is made by assessing the quality of the received signal for each antenna in the actual operating environment. As such, a switched-diversity antenna is implemented. Alternatively, as a function of the capabilities of transceiver assembly **70**, both antennas **10** and **20** may be active to perform transceive functions.

Antenna **10** and **20** are made of hard brass material of about 8 mil thickness. The brass material is selected for its oxidation and solderability properties that are favourable for the environment which the antennas are intended to operate in (e.g. hot and humid climates which would result in considerable heat and humidity under cover **90**). In other environments, copper and stainless steel would suffice, as a matter of routine design

choice.

FIG. 3 shows the antenna dimensions (including those of notch **125**) in millimeters for a resonant frequency of 915 MHz in the preferred embodiment, with details on the coupling points that gives the best return loss in a 50 ohm system. Those skilled in the art could scale the dimensions to operate at other frequencies for maximum effectiveness.

RF retrofit module **40** has a housing or frame made of polycarbonate plastic or other like material with dielectric properties that may be advantageous (e.g. fibreglass). RF Retrofit module **40** has transceiver assembly **70** but it is placed as far away as possible relative to the slot antenna **10** and **20**.

An alternative embodiment of the invention (not shown) uses a single slot antenna. The dimensions of this antenna would remain about the same as for antenna **10** or **20** but its location on the surface of the RF retrofit module **40** would change so that the (longitudinal) center of the notch **125** would align with the top or twelve o'clock position of the RF retrofit module **40** and accordingly that of the meter **100**.

An alternative embodiment of the invention (not shown) uses three slot antennas, appropriately sized, to cover the available surface area of the RF retrofit module **40**. Depending on the intended application and environment, three antennas are identical in size and shape and are equi-spaced and uniformly orientated on the surface area of RF retrofit module **40**, or they may be of differing sizes, shapes and orientations. The variations can be accomplished easily by the empirical means (e.g. experimentation for the intended application and environment with consequent design (of shape, size, orientation)).

For these alternative (single or more than two slot antennas) embodiments, the transceiver assembly **70** of the preferred embodiment (for two antennas **10** and **20**), and any upstream application, would be adapted and programmed conventionally to accommodate the single path or the switching of the multiple antenna paths, as the case may be.

Although the preferred and alternative embodiments have been given in the context of a conventional utility meter, the present invention is not limited to such contexts. The present invention teaches that incumbent or resident metallic infrastructures which are problematic because they vary, can be substantially "tamed" by inserting a second, metallic structure that becomes more "dominant" than the first mentioned "adjacent" metallic infrastructure because of its closer proximity to the radiating/receiving element of the subject antenna. This second, "dominant" metallic structure is more manageable than the varying incumbent or resident metallic infrastructures because its effects are more uniform and thus predictable.

All drawings are drawn for ease of explanation of the basic teachings of the present invention only; the extensions of the drawings with respect to number, position, relationship, and dimensions of the parts to form the preferred embodiment will be explained or will be within the skill of the art after the following teachings of the present invention have been read and understood. Further, the exact dimensions and dimensional proportions to conform to specific force, weight, strength, RF performance and similar requirements will likewise be within the skill of the art after the following teachings of the present invention have been read and understood.

Where used in the various drawings, the same numerals designate the same or

similar parts. Furthermore, when the terms "top", "bottom", "first", "second", "inside", "outside", "edge", "side", "front", "back", "length", "width", "inner", "outer", and similar terms are used herein, it should be understood that these terms have reference only to the structure shown in the drawings as it would appear to a person viewing the drawings and are utilized only to facilitate describing the invention.

Although the method and apparatus of the present invention has been described in connection with the preferred embodiment, it is not intended to be limited to the specific form set forth herein, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents, as can be reasonably included within the spirit and scope of the invention as defined by the appended claims.